CHAPTER 4

DOCUMENTATION

Chapter 4 Documentation
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4.1 Overview

4.1.1 Introduction

An important facet during the design or analysis of any hydraulic facility is the documentation. Documentation of design as used in this chapter is the compilation and preservation of the design and related information on which the design and decisions were based. This includes drainage area and other maps, field survey information, source references, photographs, engineering calculations and analyses, measured and other data and flood history including narratives from newspapers and individuals such as highway maintenance personnel and local residents who witnessed or had knowledge of an unusual event.

Appropriate documentation of the design of any hydraulic facility is essential for:

- public information,
- rational evaluation of expenditure of public funds,
- reference by designers when improvements, changes, or rehabilitations are made to the facilities,
- adequate and efficient reviews, and
- development of defense in matters of litigation.

Frequently, it is necessary to refer to plans, specifications and analysis long after the actual construction has been completed. Documentation facilitates evaluation of the performance of structures after flood events. In the event of a failure, it is essential that contributing factors be identified in order that recurring damage can be avoided.

This chapter presents guidelines for collecting and organizing the information, results, and findings obtained regarding the design of hydraulic structures so as to provide as complete a history of the design process as is practical.

4.1.2 Goal

The major goal of providing good documentation is to record the design procedure that was used and show how the final design and decisions were arrived at. Often there is expressed the myth that avoiding documentation will prevent or limit litigation losses as it supposedly precludes providing the plaintiff with incriminating evidence. This is seldom if ever the case and documentation should be viewed as the record of reasonable and prudent design analysis based on the best available technology.

Thus, good documentation should provide the following:

- demonstrate that reasonable and prudent actions were taken;
- identifying the situation at the time of design;
- document that rationally accepted procedures and analysis were used which were commensurate with the perceived site importance and flood hazard;
- providing a continuous history to facilitate future changes;
- providing the file data necessary to quickly evaluate any future site problems that might occur during the facilities service life; and
- expediting project development by clearly providing the reasons and rationale for specific design decisions.

4.2 ADOT Practice

4.2.1 Introduction

Following are ADOT's practices related to documentation of hydrologic and hydraulic designs and analyses.

1. The amount of detail of documentation for each design or analysis shall be commensurate with the risk and the importance of the facility.
2. Documentation shall be organized to be as concise and complete as practicable so that knowledgeable designers can understand years hence what was done.
3. Documentation shall include all data and information used for project development. The documents should be in a format that clearly conveys the information without adding burden for storage and copying.
4. Documentation shall be organized into reports that logically lead the reader from past history through the problem background, into the findings and through the design process.
5. Report shall include an executive summary at the beginning to assist users in finding detailed information.

The drainage report shall include all related information and data, criteria, assumptions and judgments, identification of methods and computer programs, calculations, analyses, and results used in developing conclusions and recommendations related to drainage requirements. Discussions shall address inputs, design approach, results and conclusions. Identify published data, reports, memos, letters and interviews used. If circumstances are such that the drainage facility is sized by other than normal procedures or if the size of the facility is governed by factors other than hydrologic or hydraulic factors, a narrative summary detailing the design basis shall be included in the documentation file. Additionally, the designer shall include in the drainage report items not listed herein but which are useful in understanding the analysis, design, findings and final recommendations.

4.2.2 Documentation Process

The documentation of the design is an ongoing process and is part of each step in the hydrologic and hydraulic analysis and design process. This increases the accuracy of the documentation, provides data for future steps in the plan development process, and provides consistency in the design even when different designers are involved at different times of the plan development process. Documentation shall be provided whenever any information is gathered, analyzed, evaluated or used. This can occur during any of the pre-construction phases of the project life.

The designer is responsible for documenting what hydrologic analyses, hydraulic design, and related information is gathered and developed during the project development process. The documentation file shall contain design/analysis data and all information that influenced the design. A complete hydrologic and hydraulic design and analysis documentation file, where practicable, should include such items as:

- identification and location of the facility, including photographs (ground and aerial) and vicinity maps
- topographic and contour maps, with drainage areas delineated

4.2 ADOT Practice (continued)

4.2.2 Documentation Process (continued)

- history of performance of existing structure(s), including:
  - interviews (local residents, adjacent property owners and maintenance forces),
  - newspaper clippings,
  - judgments and assumptions,
  - design notes and correspondence relating to design decisions,
  - design computations,
  - engineering cost estimates.

4.2.3 Data Types

There are three basic types of data to be documented. The types are acquired, observed and calculated.

Acquired data:
- photographs,
- mapping,
- survey,
- flood insurance studies and maps by FEMA,
- soil information,
- flood studies,
- anecdotal reports by Department personnel, newspapers and abutting property owners, and
- as-built plans and subsurface borings

Observed data:
- field trip report(s) which may include:
  - video cassette recordings,
  - audio tape recordings,
  - still camera photographs,
  - movie camera films,
  - written analysis of findings with sketches.

Calculated Data:
- hydrology
- hydraulic performance
- plans

Appendix 4-A provides a checklist of data documentation to assist in determination of completeness.

4.3 Drainage Reports

4.3.1 General

Often, the design process requires two stages of development, a preliminary stage where approximations of size are made and evaluated, and a final stage where the design is completed and contract documents are prepared.

As stated in section 4.1 Introduction:

- Documentation shall be organized into reports that logically lead the reader from past history through the problem background, into the findings and through the design process.
- Documentation shall include all data and information used for project development.
- The amount of detail of documentation for each design or analysis shall be commensurate with the risk and the importance of the facility.
- Documentation shall be organized to be as concise and complete as practicable so that knowledgeable designers can understand years hence what was done.
- Report shall include an executive summary at the beginning to assist users in finding detailed information.

Circumstances may warrant or require special solutions that are not addressed by routine forms or formulas. In such cases the report should reference the formula used and their source. If necessary a typical calculation may be shown in detail to clarify the application of the formula and logic of the solution.

The results of the calculations are to be presented in tabular summary form. Summary forms should provide space for each of the critical variables used in the calculations.

Inclusion of calculations and computer data should be organized into appendices with a summary of results as the initial entry. This same summary will often be included in the body of the report. Appendix 4-B presents a listing of items which are to be included for the design of various hydraulic structures.

4.3.2 Preliminary Drainage Report

Preliminary hydraulic reports should be as complete as possible but must be tailored to satisfy the requirements of the project. The preliminary Drainage report includes the hydrology, evaluation of existing conditions, and the stormwater management plan. If there are any issues as to how to develop the final designs, they can be addressed at this time.

4.3.3 Final Drainage Report

The final Drainage report contains all the information developed for the project, including the information that was contained in the preliminary drainage report.

4.4 References

American Association of State Highway and Transportation Officials. Highway Drainage Guidelines. 1992

Appendix 4 - A

4A.1 Project Documentation Check List

REFERENCE DATA

Maps:
USGS Quad (Scale, Date)
USGS Other
ADOT
Local Zoning Maps
Flood Hazard Delineation (Quad.)
Floodplain Delineation (HUD)
Local Land Use
Soils Maps
Geologic Maps
Aerial Photos (Scale, Date)

Studies By External Agencies:
USGS Gages & Studies
USCE Floodplain Information Report
SCS Watershed Studies
Local Watershed Management Studies
US Forest Service Studies
Interim Floodplain Studies
Water Resource Data
Regional Planning Data
Utility Company Plans

High Water Elevations:
Survey
External Sources
Personal Reconnaissance

Flood History:
Newspaper Flood Reports
External Sources
Personal Reconnaissance
Maintenance Records
Photographs

Internal Reports:
Environmental Reports
Reconnaissance Report
Location Report
Drainage Survey Inspection Report
Hydraulic Design Report
Structure Inspection Report

Appendix 4 - A

4A.1 Project Documentation Check List (continued)

HYDROLOGY

Technical Resources:
Drainage Manual

Discharge Calculations:
Drainage Areas
Soils Parameters
Hydrograph Parameters
Rainfall Runoff Models:
- Rational Formula
- HEC-1

Regression Models:
- Regional Regression Equations
- Area-Discharge Curves
- Log-Pearson Type III

HYDRAULIC DESIGN

Technical Resources:
ADOT Hydraulic Manual
FHWA Manuals

Design Procedures:
Frequency and magnitude of discharges used.
Topography used for analysis.
Hydraulic performance of existing facility for design discharges.
Analysis of hydraulic performance of proposed facility for design discharges.

Design Appurtenances:
Dissipators
Riprap
Erosion & Sediment Control

Computer Programs:
USCE HEC-RAS Water Surface Profile
FHWA HY8 Culvert Design

Appendix 4 - B

4-B.1 Design Process Documentation File Contents

4-B.1.1 Introduction

The following design inputs and results shall be included in the documentation file. The intent is not to limit the data to only those items listed, but rather identify minimum requirements, as appropriate, consistent with the hydraulic design procedures as outlined in this manual. Inclusion of calculations and computer data should be organized into appendices with a summary of results as the initial entry. This same summary will often be included in the body of the report.

Circumstances may warrant or require special solutions that are not addressed by routine forms or formulas. In such cases the report should reference the formula used and their source. If necessary a typical calculation may be shown in detail to clarify the application of the formula and logic of the solution. The results of the calculations are to be presented in tabular summary form. Summary forms should provide space for each of the critical variables used in the calculations.

4-B.1.2 Hydrology

- contributing watershed area size and identification of source (map name, etc.);
- design frequencies and basis for selection;
- identification of design values, how determined, and discussion of any unusual variance from normal usage;
  - -soil characterization
  - -development characterization
  - -rainfall amount and distribution
  - -hydrograph parameters (time of concentration, storage coefficient)
- discharges for the design frequencies to be evaluated.

4-B.1.3 Bridges

- observed highwater, dates and discharges;
- potential flood hazards to adjacent properties;
- existing roadway geometry (plan and profile);
- proposed roadway geometry (plan and profile);
- cross section(s) used;
- roughness coefficient ("n" value) assignments;
- allowable headwater elevation and basis for its selection;
- identification of the method used for computation of water surface elevations;
- stage-discharge curve for existing and proposed conditions for the design frequencies to be evaluated.
- through-bridge and channel velocity estimates for the design frequencies to be evaluated.
- calculated backwater, velocity and scour for the design frequencies to be evaluated.
- magnitude and frequency of overtopping flood, if applicable;
- bridge scour results;
- copies of all computer analyses;
- economic analysis of design and alternatives;
- complete hydraulic study report;

Appendix 4-B

4-B.1 Design Process Documentation File Contents (continued)

4-B.1.4 Culverts

- observed highwater, dates and discharges;
- potential flood hazard to adjacent properties;
- existing roadway geometry (plan and profile);
- proposed roadway geometry (plan and profile);
- allowable headwater elevation and basis for its selection;
- cross section(s) used for the downstream channel tailwater elevations;
- roughness coefficient assignments ("n" values);
- culvert entrance type;
- stage discharge information for existing and proposed conditions for the design frequencies to be evaluated;
- outlet velocity predictions for the design frequencies to be evaluated;
- predicted scour for the design frequencies to be evaluated;
- culvert outlet appurtenances and energy dissipation calculations and designs;
- copies of all computer analyses.

4-B.1.5 Open Channels

- observed highwater, dates and discharges;
- cross section(s) used in the design water surface determinations and their locations;
- roughness coefficient assignments ("n" values), existing and proposed conditions;
- identification of the method used for computation of water surface elevations;
- channel velocity and locations determinations;
- stage discharge curves for the design frequencies to be evaluated;
- water surface profiles through the reach for the design frequencies to be evaluated;
- design or analysis of materials proposed for the channel bed and banks for the design frequencies to be evaluated;
- energy dissipation calculations and designs for the design frequencies to be evaluated, and
- copies of all computer analyses.

4-B.1.6 Storm Drains

- complete drainage area map;
- design frequency;
- information concerning outfalls and existing storm drains;
- information concerning utilities and other design considerations;
- schematic of storm drain system layout;
- computations for inlets and pipes, including hydraulic grade lines.

Appendix 4 – B

4-B.1 Design Process Documentation File Contents (continued)

4-B.1.7 Pump Stations

- maximum allowable headwater elevations and related probable damage;
- inflow design hydrograph from drainage area to pump;
- sump dimensions;
- available storage amounts;
- pump sizes and operations;
- starting sequence and elevations;
- pump calculations and design report;
- line storage and pit storage capacity;
- flood frequency curve for the attenuated peak discharge.

4-B.1.8 Detention/Retention Basins

- maximum allowable headwater elevations and related probable damage;
- inflow design hydrograph from drainage area to basin;
- basin dimensions;
- available storage amounts;
- Stage-storage curve;
- Stage-discharge curve;
- Inflow hydrograph;
- Outflow hydrograph.